

Wednesday, December 5, 2007  
Vilenkin Part IV

- ## Agenda
- Announce:
    - Finish your projects!
    - Last “real” lecture!
  - Part IV

**God or Multiverse?**

OPEN DIALOGUE

*God or Multiverse?*

Howard Building, Downing College  
Cambridge

Saturday, 24th November, 2007

**THE PROGRAMME**

9:30-10:00 Registration

10:00-10:30 Bernard Carr: Introducing the Multiverse and Physical Theories of Everything

10:30-11:00 Coffee

11:00-12:00 Keith Voss: Introducing God and Theological Theories of Everything

12:10-1:00 Rodney Holder: Can a Multiverse Provide the Ultimate Explanation?

1:10-2:10 Lunch

2:20-3:10 John Polkinghorne: Metaphysics of Everything

3:10-4:40 Peter Cole: Can the Universe Explain itself?

4:50-5:00 General Discussion

A remarkable feature of the Universe is that the physical constants appear to be fine-tuned for the emergence of life. One possible explanation for this is that a Creator designed the Universe for our benefit. Another – prompted by recent developments in cosmology and particle physics – is that there could be many universes in which the constants are different, in which case the observed fine-tunings just indicate a selection effect. Some physicists regard this “Multiverse” hypothesis as more plausible since it is predicted by respectable (albeit speculative) physics but others regard it as just as metaphysical as believing God since the other universes can never be seen. One might also argue that a God who can create a Universe could equally well create a Multiverse.

This day provides a unique opportunity for three theologians – Dr. Rodney Holder, Dr. John Polkinghorne and Prof. Keith Voss – to join two cosmologists – Prof. Bernard Carr and Prof. Peter Cole – in a discussion of these issues. They do not expect to answer the question posed by the title definitively but they will explore all possible values: (1) no Multiverse and no God; (2) the case where God and the Multiverse are equally unpalatable; (3) Multiverse and no God; (4) those who regard the Multiverse as the natural agnostic explanation of fine-tuning; (5) no Multiverse and God (the standard theological view); (6) Multiverse and God (an alternative theological view). At the end of the day there will be a general discussion, with contributions from the floor.

SPEAKERS:  
Prof. Bernard Carr  
Prof. Peter Cole  
Rev. Dr. Rodney Holder  
Sir. John Polkinghorne FRG  
Prof. Keith Voss FRSA

*“The multiverse is the last resort for the desperate atheist”*  
Neil Manson

The Scientific and Medical Network

- ## Ch. 16—Did The Universe have a beginning?
- Has it existed forever or did it start at some time?

## An Oscillating Universe

- Expand
- Contract
- Big Crunch
- Big Bang
- Repeat!

But the entropy must get reset to a low value!

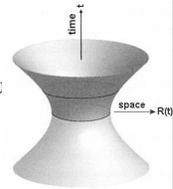
- ## Steinhardt & Turok Fix it
- Expanding fireball
  - Vacuum energy dominates
  - Slow inflation for a long time
  - Eventual collapse (minimal collapse)
  - Big Bang & repeat
- Volume keeps increasing, so entropy can as well!  
But...entropy in our observable universe can be made small by collapse

## So, does it have a beginning?

- W/ eternal inflation or cyclic Universe, might think Universe could have existed forever (no beginning)
- Still need to keep thinking

## De Sitter Space

- Inflation described by De Sitter space (in simplified version...homogenous)
- If we look to late times, no problem...keeps inflating
- If we look backwards, we find island universes must have begun in a Big Bang



## Generalize...

- Choose some people/observers in the universe predicted by eternal inflation
- If the universe had \*no\* beginning...
- Then observers' paths should extend infinitely into the past
- But they don't...so there's a contradiction
- Universe had a beginning
- Also applies to cyclic universe since it too involves continued, average expansion

## Ch. 17—How did things begin then?

- Classically, at the beginning, if the Universe was
  - **Small**...not much vacuum energy, regular energy/mass dominates and Universe **collapses**
  - **Large**...vacuum energy dominates, and Universe **expands**
- But, quantum mechanically, small Universe can tunnel to larger one and inflate

## Nucleation From Nothing

- Nothing existed
- Quantum fluctuations occur randomly
- At many of these, Universe is born, recollapses and is gone
- At one (more?), small Universe is born, tunnels to bigger one, inflates, and here we are!

## Similar to existing idea

- Quantum fluctuations would eventually produce patch of inflating region
- Region expands and pinches off into its own Universe
- Energy still conserved: negative gravitational potential energy balances positive energy
- Problems:
  - Small probability
  - Assumes existence of "mother" universe...doesn't answer question of origin

## Ch. 18—How will it end?

- W/ no cosmological constant:
  - Closed (overdense)—fireball as universe collapses
  - Critical—expansion continues to stop
  - Open (underdense)—heat death, everything expands away
- Like launching a space craft...throw very fast, too slow, or just right

## How will it end?

- w/ Inflation
  - Driven to critical density
  - Greater Universe continues—inflation is eternal
- w/ Cosmological Constant
  - Local group continues to exist (galaxies within merge)
  - All else disappears from view
- Cosmological “Constant” might decrease...when it goes negative, Big Crunch
- String-motivated ideas propose creation of bubbles of negative cosmological constant which, if they bump into us, would annihilate us

## Does Inflation work?

- Does it explain things?
- Does it do so better:
  - More elegantly
  - Fewer assumptions
  - Fewer ad hoc arguments
  - More naturally

## What’s the difference between an O-region and another (island) Universe?

- A. No difference
- B. Things in our O-region can affect things in another, but not so for Universes
- C. Things in our Universe can affect things in another, but not so for O-regions

## What’s the density of the Universe?

- A. Underdense
- B. Critical
- C. Overdense

## What is not a difference between inflation and a cosmological constant?

- A. Inflaton evolves in time
- B. Inflaton has negative pressure, but constant does not
- C. Inflaton implies exponential expansion but constant may just produce “mild” expansion

What does it mean to say that the vacuum energy comes to “dominate”?

- A. When there’s not much space, then vacuum energy is more important than regular matter
- B. When there’s lots of space, there’s lots of vacuum energy which becomes more important than regular matter

Why does vacuum energy mess up easy picture of closed/critical/open?

How does the scalar field get to the top of the hill?